

**Translation of Jap. Pat. Appl. Kokai Publication No. H07-325280 (A)**

Application No. H07-085960  
Filing Date 20 March 1995  
Publication Date 12 December 1995  
Int. Cl.<sup>6</sup> G02F 1/13; G02F 1/1333; G02F 1/1339  
Priority Data Japan, 8 April 1994, Patent Application No. H06-093870  
Inventors Tatsuya Tabei, Masuyuki ANDOH, Hideshi HATTORI  
and Noburu MIYANOWAKI  
Applicant Dai Nippon Printing Co., Ltd.

**Title**

Method of Manufacturing a Liquid Crystal/Polymer Composite Optical Element

**Abstract**

**OBJECT:** To provide a method of manufacturing a liquid crystal/polymer composite optical element, said method enabling easy manufacture of a liquid crystal/polymer composite optical element of arbitrary size.

**CONSTITUTION:** In the context of a method for cutting out, to a prescribed size, a liquid crystal optical element formed by sandwiching a liquid crystal/polymer composite film between two substrates, at least one of which is transparent, said liquid crystal/polymer composite film comprising liquid crystal particles dispersed in a polymer matrix: a method of manufacturing a liquid crystal/polymer composite optical element wherein a laser is used as the cutting means.

**Claims**

1. In the context of a method for cutting out, to a prescribed size, a liquid crystal optical element formed by sandwiching a liquid crystal/polymer composite film between two substrates, at least one of which is transparent, said liquid  
5 crystal/polymer composite film comprising liquid crystal particles dispersed in a polymer matrix: a method of manufacturing a liquid crystal/polymer composite optical element wherein a laser is used as the cutting means.
2. The method of manufacturing a liquid crystal/polymer composite optical element set forth in claim 1, wherein the two substrates are conductive substrates.
- 10 3. The method of manufacturing a liquid crystal/polymer composite optical element set forth in claim 1, wherein one of the two substrates is a conductive substrate and the other is a protective layer.
4. The method of manufacturing a liquid crystal/polymer composite optical element set forth in claim 2 or claim 3, wherein the conductive substrates or substrate  
15 comprise or comprises polymer film, polymer sheet or resin sheet.

**Detailed Description of the Invention [1]\*****Industrial field of utilisation**

- (1) The present invention relates to a liquid crystal/polymer composite optical  
20 element that is responsive to electric fields and heat, and that employs a liquid crystal/polymer composite film capable of displaying and/or recording information. The liquid crystal/polymer composite optical element of this invention has a wide

\* Numbers in square brackets refer to Translator's Notes appended to the translation.

range of possible applications, including displays, light-modulating panels [2], and rewritable display and recording media (cards, OHP, etc.).

#### Prior art

(2) Due to various characteristics such as their low power consumption, lightweight nature and thinness, liquid crystal displays are widely used to display text characters and pictures in applications such as wrist watches, calculators, personal computers and televisions. Ordinary TN- and STN-liquid crystal displays are fabricated by enclosing liquid crystal inside a sealed cell between glass sheets having transparent electrodes, and sandwiching this assembly between polarizing plates.

(3) However, a number of problems are encountered with such liquid crystal displays, including (a) because two polarizing plates are required, the viewing angle is small, and because brightness is insufficient, a high power consumption backlight is necessary; (b) large-area displays are difficult to achieve because of the large cell thickness dependence [3]; (c) the complexity of the structure of such displays and the difficulty of enclosing liquid crystal in a cell leads to high manufacturing costs. Accordingly, there are limits to the extent to which liquid crystal displays can be made lighter, thinner, larger, lower in power consumption, and cheaper.

(4) It is anticipated that liquid crystal/polymer composite optical elements based on light scattering mechanisms and employing liquid crystal/polymer composite films obtained by dispersing liquid crystal in a polymer matrix, will find application as liquid crystal display media that effectively overcome the problems described above. Such optical elements are currently the focus of much R&D activity. The principal methods of manufacturing this kind of liquid crystal/polymer composite optical element employing a crystal/polymer composite film are as follows.

(5) (i) Impregnating a porous polymer with liquid crystal; (ii) manufacturing from an emulsion comprising liquid crystal dispersed in an aqueous solution of polyvinyl alcohol (see PCT (WO) S58-201631 [4]); (iii) casting the solution obtained by dissolving liquid crystal and a polymer matrix in a common solvent, followed by phase separation of liquid crystal and polymer accompanying removal of the solvent (see PCT (WO) S61-502128 [5]); (iv) polymerisation of the monomer in a mixture of liquid crystal and monomer, followed by obtaining a phase-separated structure of liquid crystal and polymer (see PCT (WO) S61-502128). Of these methods, method (ii) has the advantages of simple and convenient manufacture, easy control of structure and film thickness, and the ability to manufacture large panels, and this method has already been put to practical use in the manufacture of glass for light-modulating panels.

#### Problem that the invention is intended to solve

(6) Methods employed to manufacture the liquid crystal/polymer composite film used in a conventional liquid crystal/polymer composite film optical element include: (i) using UV or heat to polymerize a liquid crystal/monomer (or oligomer) solution and then causing the liquid crystal particle phase to separate; and (ii) applying and drying a liquid crystal emulsion on a substrate. Both these methods offer the possibility of forming elements with a wide range of areas ranging from extremely small to large. However, both methods require — when sandwiching the fabricated liquid crystal/polymer composite film between a pair of electrode substrates or between an

electrode substrate and a protective layer — prevention of leakage, etc., of liquid crystal from edges, and this is achieved by for example using a sealant along the perimeter of the liquid crystal/polymer composite film.

5 (7) Consequently, if it were possible to manufacture an element of large area in advance and then to cut this element into arbitrary sizes, it would be possible to manufacture, continuously and very easily, elements of various sizes. However, in the manufacturing methods described above, the perimeter of the liquid crystal/polymer composite film where the element has been cut out is not sealed by a sealant, which leads to the complication that some sort of sealing process has to be applied to this  
10 perimeter. It is therefore an object of the present invention to provide a method whereby a liquid crystal/polymer composite optical element of arbitrary size can be manufactured easily.

#### Means for solving problem

15 (8) The foregoing object is achieved by this invention. Namely, in the context of a method for cutting out, to a prescribed size, a liquid crystal optical element formed by sandwiching a liquid crystal/polymer composite film between two substrates, at least one of which is transparent, said liquid crystal/polymer composite film comprising liquid crystal particles dispersed in a polymer matrix: a method of manufacturing a liquid crystal/polymer composite optical element wherein a laser is used as the cutting  
20 means.

#### Working of the invention

(9) When a laser is employed to cut out a liquid crystal/polymer composite optical element that has been manufactured using a resin substrate as the conductive substrate of the element, the cut surfaces are fusion-sealed simultaneously with being  
25 cut, and steps such as fabricating a seal and/or applying a sealant are unnecessary, with the result that manufacture of an element of arbitrary size is simpler and leakage of liquid crystal from the cut surfaces is automatically prevented. For example, by cutting out an element of arbitrary size using light from a powerful laser such as a carbon dioxide gas laser, the cut surfaces of the matrix polymer of the liquid  
30 crystal/polymer composite film — or the cut surfaces of the polymer film, polymer sheet or resin sheet sandwiching the composite film — melt and fuse together, with the result that it is not necessary to use a separate sealant to seal the edges of the element. Accordingly, it is easy to manufacture a liquid crystal/polymer composite optical element of arbitrary size.

#### 35 Preferred mode of embodying the invention

(10) This invention will now be described in greater detail in terms of a preferred mode of embodiment. As used in the present invention, "liquid crystal" signifies an organic mixture [6] that exhibits a liquid crystal state in the vicinity of ordinary temperatures, and encompasses nematic, cholesteric and smectic liquid crystals. The  
40 liquid crystal is selected in accordance with the intended application of the optical element obtained by the method of the invention. For example, if the application is to a display, a nematic liquid crystal is used, while a smectic liquid crystal is used if the application is to a rewritable display medium. It is also feasible to add a dye or pigment to the liquid crystal in order to improve contrast or colour. If a dichroic dye is  
45 added, it is feasible to use the element not only as a scattering/transmitting type

composite film, but also — due to the guest/host effect of the dye — as a composite film capable of switching between optical absorption (coloured) and a transparent state.

5 (11) If too much dye is added, a large quantity of dye dissolves into the polymer matrix, resulting in undesirable residual colour when the voltage is applied. On the other hand, if there is too little dye, there is less difference between the absorption of light during voltage application and absorption when no voltage is applied, with the result that there is insufficient improvement in contrast. Hence the amount of dye added varies according to the intended application of the liquid crystal optical element  
10 obtained in this invention, and according to the liquid crystal material used, etc. For example, if the optical element is to be used for a display employing nematic liquid crystal, the dye is preferably used in the range 0.1 - 5 wt% relative to liquid crystal in the composite film. If the optical element is to be used as a rewritable display medium employing smectic liquid crystal, the dye is preferably used in the range 1 -  
15 10 wt% relative to liquid crystal.

(12) The conductive substrate used in this invention is one that is generally used in conventional and well-known liquid crystal/polymer composite optical elements. Any conventional and well-known conductive substrate can be used in this invention, and specifically, this substrate is an electrode substrate comprising for example a  
20 transparent conductive material such as ITO,  $\text{SnO}_2$  or  $\text{ZnO}$  deposited on a transparent substrate of for example polymer film, polymer sheet or resin sheet. If a non-transparent conductive substrate is used and its electrodes are required to function also as reflective sheets, it is preferable to use a substrate provided with, by way of example, aluminium reflective electrodes. However, in this case it is also feasible to  
25 use a substrate wherein electrodes of a transparent conductive material such as ITO,  $\text{SnO}_2$  or  $\text{ZnO}$  have been provided on white PET film or the like.

(13) The liquid crystal/polymer composite film formed between the aforementioned substrates may be formed by the conventional and well-known liquid crystal emulsion or phase separation method, and is preferably formed by the emulsion method. PVA is  
30 preferably employed as the matrix resin that is used in the emulsion method. However, gelatin, acrylic copolymer, water-soluble alkyd resin or the like can be used, provided that the substance can be dispersed or dissolved in water.

(14) The proportion in which the matrix resin and the liquid crystal are used — i.e., the matrix polymer/liquid crystal mixing ratio (or weight ratio) — varies according to  
35 the intended application of the optical element. For example, when the application is a display employing nematic liquid crystal, the mixing ratio is preferably in the range 5/95 - 50/50. When the application is to a rewritable display medium employing smectic liquid crystal, the mixing ratio is preferably in the range 5/95 - 95/5, and more preferably in the range 55/45 - 35/65. In both these applications, a number of  
40 unsatisfactory effects occur if the quantity of liquid crystal used is too small, including insufficient transparency under applied voltage and the necessity of using a large voltage to make the film transparent. On the other hand, if the amount of liquid crystal used is too great, there is insufficient scattering (turbidity) when no voltage is applied and film strength may decrease.

(15) There are a number of methods that can be used to disperse the liquid crystal in an aqueous solution of polymer matrix, including (a) mixing using any of a variety of agitators such as an ultrasonic disperser, and (b) membrane emulsification (see T. Nakajima and M. Shimizu, *Pharmtech Japan*, Vol. 4, No. 10, 1988). The size of the liquid crystal emulsion particles depends on the dispersion method used and on the intended application of the optical element. If the optical element is to be used as a display, the volume-average particle size (or diameter) of the liquid crystal particles is preferably in the range 0.5 - 2  $\mu\text{m}$ , the weight-average particle size is in the range 1.1 - 2.1  $\mu\text{m}$ , and the number-average particle size is in the range 0.9 - 1.5  $\mu\text{m}$ . When the application is to a rewritable display medium, the preferred volume-average particle size is given by the requirement that liquid crystal particles of 1  $\mu\text{m}$  or less account for no more than 10% of all particles.

(16) The method employed for coating the liquid crystal emulsion onto the aforementioned element substrate can be any conventional and well-known coating method such as doctor coating or blade coating, but electrodeposition coating would be preferable. Because electrodeposition coating can increase the liquid crystal content of the liquid crystal/polymer composite film, a film with superior electro-optical characteristics can be formed. This coating method also enables film thickness to be controlled with a high degree of precision and facilitates the formation of fine patterns of liquid crystal/polymer composite film. The coated liquid crystal emulsion becomes a liquid crystal/polymer composite film by being dried at room temperature or at a temperature that does not affect the emulsion.

(17) The thickness of the liquid crystal/polymer composite film differs according to the application of the optical element. For example, if a liquid crystal display element is to be used as a display, the thickness of the liquid crystal/polymer composite film formed between the pair of substrates is generally preferably about 3 - 13  $\mu\text{m}$ . When the element is to be used in application to a rewritable display medium, the thickness of the composite film sandwiched between the conductive substrate and the protective layer is preferably approximately 3 - 23  $\mu\text{m}$ . In both these applications, a film thickness that is less than the preferred range has unfavorable consequences, including lower display contrast, while a film thickness that exceeds the preferred range has unfavorable consequences such as a higher voltage (i.e., drive voltage) being required to erase the display. An optical modulating element can be obtained by using a conventional method to affix opposed electrodes to the surfaces of the liquid crystal/polymer film formed on the element substrate in the manner described above, or by providing protective layers. [7]

(18) When a liquid crystal optical element according to this invention is to be used, by way of example, in a display application, the liquid crystals in the nematic liquid crystal/polymer composite film become oriented when a voltage is applied, thereby allowing light to pass through so that the liquid crystal layer assumes the background colour. When no voltage is applied, the orientation of the liquid crystals is lost and the liquid crystal layer assumes the colour of the dichroic dye. Accordingly, a display is obtained by turning an applied voltage either on or off, and is erased by performing the opposite action.

(19) When a liquid crystal optical element according to this invention is to be used, by way of example, as a rewritable display medium, the liquid crystals in the smectic liquid crystal/polymer composite film become oriented when a voltage is applied, thereby allowing light to pass through so that the liquid crystal layer assumes the background colour. Heating results in a disordering of the orientation of the liquid crystals, with the result that the liquid crystal layer assumes the colour of the dichroic dye. Accordingly, writing is performed by applying one of (i) voltage, (ii) heat, and erasing is performed by applying the other. If there is just a single electrode above or below, or a single conductive substrate, voltage can be applied by means of corona charging.

(20) The laser used to cut out the element can be, for example, an argon or other ion laser, a carbon dioxide gas laser, a semiconductor laser, an excimer laser, a dye laser, a YAG laser, or a chemical laser. If circumstances require an increase in the absorption efficiency of laser light when cutting out the element, an optical conversion material such as a dye can be added to the substrate film. It is also feasible to provide, on the film, a layer containing an optical-to-thermal conversion material. In this case, in order not to impair the optical transmittance of the display region, the layer containing the optical-to-thermal conversion material is preferably provided on a pattern, this being formed by printing or other method on the parts to be cut. Because the parts of the substrate to be cut fuse together immediately in the cutting process due to the heat, short-circuits readily occur between the upper and lower electrodes if a conductive thin film has been provided on both the upper and lower substrates at the parts to be cut. Accordingly, this conductive thin film is preferably removed from the parts to be cut of at least one of the substrates.

(21) The invention will now be described in greater detail with reference to a number of working examples.

#### Working Example 1

An O/W type liquid crystal emulsion was prepared by membrane emulsification from the following composition:

oil phase	nematic liquid crystal (BL-010, manufactured by Merck)	100.0 g
water phase	polyvinyl alcohol (KP-060, manufactured by Nippon Synthetic Chemical Industry Co., Ltd.)	10.3 g
water		195.7 g

70 g of 20 wt% aqueous solution of KH-20 (a polyvinyl alcohol manufactured by Nippon Synthetic Chemical Industry) was added to this emulsion, which was then applied to an ITO-on-PET film by blade coating. The coating was dried for 24 hours at room temperature to obtain an 8  $\mu$ m thick liquid crystal/polymer composite film. A large-area cell was manufactured by laminating with another ITO-on-PET film. [8] This cell was then cut out to A4 size using a carbon dioxide gas laser (an RF-pumped CO<sub>2</sub> laser, Model No. 48-5-28W, manufactured by the US company Synrad, with output controlled by Synrad's UC-1000 Universal Controller). The cut surfaces fused together and no liquid crystal leaked out.

**Working Example 2**

(22) A large-area cell of liquid crystal/polymer composite film was manufactured as follows. A 40:60 (weight ratio) mixture of bifunctional epoxy ester 40EM (manufactured by Kyoisha Yushi Chemical Co., Ltd.) and nematic liquid crystal E-44 (manufactured by Merck) was prepared. 3 wt% of photopolymerization initiator Darocure 1116 (manufactured by Merck) was added to this. The resulting composite was gravure coated onto ITO-on-PET film at 60°C, and then wet-laminated with ITO-on-PET film. This was followed by UV irradiation, still at 60°C, using a high-pressure mercury vapor lamp (80 W). When the resulting cell was cut out in the same manner as Working Example 1, the cut surfaces fused together and no liquid crystal leaked out.

**Working example 3**

(23) An O/W type liquid crystal emulsion was prepared by ultrasonic dispersion from the following composition:

smectic liquid crystal (S-6, manufactured by Merck)	20 g
polyvinyl alcohol (EG-05, manufactured by Nippon Synthetic Chemical Industry Co., Ltd.)	1.5 g
water	30 g

10 g of 20 wt% aqueous solution of polyvinyl alcohol (KH-20, manufactured by Nippon Synthetic Chemical Industry) was added to this emulsion, which was then applied to an ITO-on-PET film by blade coating. The coating was dried for 20 hours at room temperature to obtain an 8  $\mu$ m thick liquid crystal/polymer composite film. A large-area cell was manufactured by laminating another ITO-on-PET film onto the surface of this film. When this cell was cut out to A4 size using the same method as in Working Example 1, the cut surfaces fused together and no leakage of liquid crystal was observed.

**Working Example 4**

(24) A liquid crystal/polymer composite film (8  $\mu$ m thick after drying) was formed on an ITO-on-PET film by the same method, using a liquid crystal emulsion with the same composition as in Working Example 3 except that 2 wt% of dichroic dye (S-428, manufactured by Mitsui Toatsu Chemicals, Inc.) was dissolved in the liquid crystal. Blade coating was employed to apply a 15 wt% aqueous solution of polyvinyl alcohol (KH-20, manufactured by Nippon Synthetic Chemical Industry) to this film surface, and a PVA film (5  $\mu$ m thick after drying) was formed. The large-area liquid crystal/polymer composite sheet thereby obtained was cut out to credit card size [9] using the same method as in Working Example 1. It was possible to utilize the large-area liquid crystal/polymer composite sheet without waste, and the cut surfaces fused together with no leakage of liquid crystal.

**Advantages of the invention**

(25) As has been described above, with the present invention, when a laser is employed to cut out a liquid crystal/polymer composite optical element that has been manufactured using a resin substrate as the conductive substrate of the element, the cut surfaces are fusion-sealed simultaneously with being cut, and steps such as

fabricating a seal and/or applying a sealant are unnecessary, with the result that manufacture of an element of arbitrary size is simpler and leakage of liquid crystal from the cut surfaces is automatically prevented.

#### TRANSLATOR'S NOTES

---

1. Numbers in round brackets at the beginning of paragraphs correspond to the paragraph numbering in the Japanese specification.
2. The Japanese term that I have translated as "light-modulating panels" is typically used to signify large panels of laminated glass between which is sandwiched liquid crystal sheet. Such panels are referred to in the literature as "switchable light control glass". Typical literature states that "with the development of special liquid crystal sheet, it is now possible to use switchable light control glass as ordinary glass by having large size capability up to 900-2400 mm. This is one of the reasons why many applications in displays and architectural field [sic] can be considered."
3. Sic. I am not sure exactly which limitation the writer is referring to.
4. This refers to the published Japanese translation of a PCT application in which Japan was named as one of the countries. S58-201631 signifies Pub. No. 201631 of 1983.
5. S61-502128 signifies Pub. No. 502128 of 1986.
6. Sic.
7. Sic. This sentence does not seem very clearly written in the original Japanese.
8. Sic. The writer presumably means that the liquid crystal/polymer composite film was sandwiched between two layers of PET.
9. I think the writer uses this phrase to mean that the entire large sheet was cut into credit card sized pieces.

- TI - FORMATION OF LIQUID CRYSTAL/HIGH POLYMER COMPOSITE OPTICAL ELEMENT
- ABD - 19960430
- AB - PURPOSE: To provide a forming method of liquid crystal/high polymer composite optical element capable of easily forming a liquid crystal/high polymer composite optical element having an optional size.
- CONSTITUTION: In a method for cutting into a prescribed size a liquid crystal optical element formed by inserting a liquid/high polymer composite film obtained by dispersing a liquid crystal particle in a high polymer matrix between two substrates, at least one of which is transparent, laser is used as the cutting means.
- PN - JP 7325280A 19951212
- .BV - 199604
- PD - 1995-12-12
- PA - DAINIPPON PRINTING CO LTD
- I - G02F1/13, G02F1/1333, G02F1/1339

(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平7-325280

(43) 公開日 平成7年(1995)12月12日

(51) IntCl. <sup>6</sup>	識別記号	庁内整理番号	F I	技術表示箇所
G 0 2 F	1/13	1 0 1		
	1/1333			
	1/1339	5 0 5		

審査請求 未請求 請求項の数 4 F D (全 5 頁)

(21) 出願番号	特願平7-85960	(71) 出願人	000002897 大日本印刷株式会社 東京都新宿区市谷加賀町一丁目1番1号
(22) 出願日	平成7年(1995)3月20日	(72) 発明者	田部井 達也 東京都新宿区市谷加賀町一丁目1番1号 大日本印刷株式会社内
(31) 優先権主張番号	特願平6-93870	(72) 発明者	安藤 雅之 東京都新宿区市谷加賀町一丁目1番1号 大日本印刷株式会社内
(32) 優先日	平6(1994)4月8日	(72) 発明者	服部 秀志 東京都新宿区市谷加賀町一丁目1番1号 大日本印刷株式会社内
(33) 優先権主張国	日本 (J P)	(74) 代理人	弁理士 吉田 勝広 (外1名) 最終頁に続く

(54) 【発明の名称】 液晶／高分子複合型光学素子の作製方法

(57) 【要約】

【目的】 任意のサイズの液晶／高分子複合型光学素子を容易に作製することが出来る液晶／高分子複合型光学素子の作製方法を提供すること。

【構成】 液晶粒子が高分子マトリックス中に分散してなる液晶／高分子複合膜を、少なくとも一方が透明である2枚の基板間に挟持してなる液晶光学素子を所定のサイズに裁断する方法において、裁断手段としてレーザーを用いることを特徴とする液晶／高分子複合型光学素子の作製方法。

高分子或は液晶／高分子複合膜をサンドイッチしている高分子フィルム、高分子シート又は樹脂板の溶融及び融着が生じ、素子の端部を別途シール剤で封止する必要がないので任意の大きさの液晶／高分子複合型光学素子を容易に作製することが出来る。

【0010】

【好ましい実施態様】次に好ましい実施態様を挙げて本発明を更に詳しく説明する。本発明で云う液晶とは、常温付近で液晶状態を示す有機混合物であって、ネマチック液晶、コレステリック液晶、スメクチック液晶が含まれる。液晶は本発明方法で得られる光学素子の用途に応じて選択されるが、例えば、ディスプレイ用途にはネマチック液晶が、書き換え可能な表示媒体としての用途にはスメクチック液晶が用いられる。尚、液晶中にコントラスト或いは色調を改善させる為に色素を含有させることも出来る。二色性色素を添加した場合には、散乱-透過型の複合膜としてばかりでなく、色素のゲスト-ホスト効果により、光吸収(着色)-透明状態でスイッチングする複合膜として使用することも出来る。

【0011】色素の添加量が多過ぎると高分子マトリックスへの溶解が多くなり、電圧印加時の色残りが生じて好ましくない。又、色素の量が少な過ぎると電圧印加時と無印加時の光の吸収の差が小さくなり、コントラストの向上効果が十分ではない。その為に、本発明で得られる液晶光学素子の用途及び液晶材料等によって添加量は異なるが、例えば、光学素子をネマチック液晶を用いるディスプレイ用途として用いる場合には、複合膜中の液晶に対して0.1~5重量%の範囲で使用する事が好ましい。光学素子をスメクチック液晶を用いる書き換え可能な表記媒体として使用する場合には、液晶に対して1~10重量%の範囲で使用する事が好ましい。

【0012】本発明で使用する導電性基板は、従来公知の液晶／高分子複合型光学素子に一般的に使用されているものであって、本発明では、従来公知の導電性基板はいずれも使用可能であり、具体的には、例えば、ITO系、SnO<sub>2</sub>系、ZnO系の様な透明導電性材料を、例えば、高分子フィルム、高分子シート或は樹脂板等の透明基板に付着させた電極基板である。不透明導電性基板を用いる場合には、その電極が反射板としての機能も要求されるときは、例えば、アルミニウム反射電極を設けた基板が好ましいが、白色PETフィルム等にITO系、SnO<sub>2</sub>系、ZnO系の様な透明導電性材料による電極を設けた基板も使用することができる。

【0013】上記基板間に形成する液晶／高分子複合膜は、従来公知の液晶エマルジョン法によるものでも相分離法によるものでもよく、特に限定されないが、エマルジョン法によるものが好ましい。エマルジョン法で使用するマトリックス樹脂としては、PVAが好ましく用いられるが、ゼラチン、アクリル酸共重合体、水溶性アルキド樹脂等、水に分散若しくは溶解するものであ

ればよい。

【0014】これらのマトリックス樹脂と液晶との使用割合としては、マトリックス高分子／液晶の混合比(重量比)は、光学素子の用途で異なるが、例えば、ネマチック液晶を用いるディスプレイ用途として使用する場合には、5/95~50/50の範囲が好ましく、スメクチック液晶を用いる書き換え可能な表示媒体としての用途では、5/95~95/5の範囲が好ましく、更に好ましくは55/45~35/65の範囲である。それぞれの用途においても、液晶の使用量が少なすぎると、電圧印加時の透明性が不足するだけでなく、膜を透明状態にする為に多大の電圧を必要とする等の点で不十分であり、一方、液晶の使用量が多すぎると、電圧無印加時の散乱(濁度)が不足するだけでなく、膜の強度が低下したりするので好ましくない。

【0015】高分子マトリックスの水溶液に前記液晶を分散させる方法としては、超音波分散機等の各種の攪拌装置による混合方法や、膜乳化法(中島忠夫・清水政高、PHARMTECH JAPAN 4巻、10号(1988)参照)等の分散方法等が挙げられる。液晶エマルジョン粒子の大きさは、用いる分散方法や光学素子の用途に依存するが、ディスプレイ用途として用いる場合には、体積分布において液晶粒子の平均粒子径(直径)が0.5~2μmの範囲にあり、重量分布において液晶粒子の平均粒子径(直径)が1.1~2.1μmの範囲にあり、又、個数分布において液晶粒子の平均粒子径(直径)が0.9~1.5μmの範囲にあることが望ましい。書き換え可能な表示媒体用途においては、体積分布における平均粒子径(直径)が1μm以下の液晶粒子が全粒子の10%以下であることが好ましい。

【0016】上記素子基板上に液晶エマルジョンをコーティングする方法としては、ドクターコーティング法やブレードコーティング法等の従来公知のいずれのコーティング方法も使用することが出来るが、好ましい1例としては、電着コーティング法が挙げられる。この電着コーティング方法では、液晶／高分子複合膜中の液晶含率を高くすることが出来る為、電気光学特性に優れた膜を高い膜厚精度で形成することが出来る。又、微細なパターン状に液晶／高分子複合膜を形成させることも可能である。塗布された液晶エマルジョンは、室温又はエマルジョンに影響を与えない程度の温度で乾燥させることによって液晶／高分子複合膜となる。

【0017】液晶高分子複合膜の厚みは、光学素子の用途によって異なり、例えば、液晶表示素子をディスプレイ用途として使用する場合には、一対の基板間に形成される液晶／高分子複合膜の厚みは一般的に約3~13μm程度が好ましい。又、該素子を書き換え可能な表示媒体用途として使用する場合には、導電性基板と保護層に挟持される該複合膜の厚みは、約3~23μm程度が好ましい。それぞれの用途においても、膜厚が上記範囲未

(5)

特開平7-325280

7

8

した。得られた大面積液晶／高分子複合型シートを実施例1と同じ方法で、クレジットカード・サイズに裁断した。大面積液晶／高分子複合型シートは無駄なく利用することができ、裁断面は融着し、液晶のしみだしはなかった。

【0025】

【効果】以上の如き本発明によれば、素子の導電性基板

として樹脂製の基板を使用して作製された液晶／高分子複合型光学素子をレーザーで裁断すると、裁断面が裁断と同時に融着封止され、セルの作製やシール剤の塗布等の工程が不要となり、任意のサイズの素子の作製が簡単となるばかりか、裁断面からの液晶のしみだしを自動的に防止することが可能となる。

---

フロントページの続き

(72)発明者 宮之脇 伸

東京都新宿区市谷加賀町一丁目1番1号

大日本印刷株式会社内

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

☐ BLACK BORDERS

☒ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES

☐ FADED TEXT OR DRAWING

☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING

☐ SKEWED/SLANTED IMAGES

☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS

☐ GRAY SCALE DOCUMENTS

☐ LINES OR MARKS ON ORIGINAL DOCUMENT

☒ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY

☐ OTHER: \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**